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Rising Productivity of Australian Trading Banks Under Deregulation 1986-1995

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Abstract

Productivity of four major trading banks and six regional banks is investigated using Malmquist productivity indices in the deregulated period 1986-1995. The principal findings indicate an overall rise in total productivity driven more by technological progress than technical efficiency. Performance of major trading banks on technical efficiency is similar to that of regional banks but higher on technological progress. Distinguishing between improvement in technical efficiency and technological change is significant for policy formulation. Technological innovation can be construed as a sign of dynamic efficiency where banks take advantage of new cost-effective technologies and pursue product and market development. (*JEL* D24, G21)

Introduction

This paper examines the changes in productivity of the retail-banking sector in the deregulated period 1986-1995. Productivity of four major Australian trading banks and six regional banks is investigated over the ten-year period using Malmquist productivity indices (MPI). Malmquist indices capture the overall change in productivity, as well as provide a breakdown into technical efficiency (TE) and technological change (TC). That is, an increase in productivity from one year to the next may be due to improved technical efficiency, technological progress, or a combination of the two.

Measuring technical efficiency is an attempt to quantify how well the inputs are converted into outputs by the production process. However, used in isolation, technical efficiency can be a misleading measure of productivity for an organisation or industry where major environmental changes are under way, e.g., deregulation or technological change. Another source of productivity improvement that should be studied is technological progress. Technological progress represents a

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shift of the efficient frontier due to technological innovation, and it should be distinguished from gains in technical efficiency represented by units moving toward the frontier. The Malmquist index is often used to measure technological progress (Coelli, Rao, and Battese 1998).

This paper continues the research begun in another study of the same period where pure technical efficiency (PTE), scale efficiency (SE), and returns to scale were investigated through data envelopment analysis (DEA) (Avkiran 1999a). The primary motivation for this study is to contribute to the debate about the productivity of the sector and provide empirical evidence that can help new policy formulations in the deregulated era.

Deregulation of the Australian finance sector began in December 1983 when the dollar was floated and exchange controls lifted. Australia entered the deregulated period with 24 banks. Deregulation continued to unfold with lifting of deposit controls, authorisation of savings banks to provide chequing facilities, invitation of foreign banks to operate in Australia, changes in ownership of authorised money market dealers, expansion of services by credit unions and building societies, and so on. However, these changes in the structure of the finance sector do not easily lead to comparative pre-deregulation and post-deregulation studies.[1] In addition, the deregulation literature from the rest of the world provides no conclusive findings (Berger and Humphrey 1997) that Australian policy makers can use with confidence. Hence, there is still a need for research in this area.

As a direct result of deregulation, Australian banks are facing more competition from building societies, credit unions, and mortgage originators. In the last five years or so, the lines separating the banks and other financial institutions have become less well defined. Taking advantage of legislative and technological changes, state banks, regional banks, and building societies are competing head-on with larger banks across both geographical boundaries and product range.

The Australian banks have responded to increased competition through such practices as securitisation, generating revenue from fees rather than the interest spread, product innovation, and new delivery channels. For example, banks are entering collaborative agreements with major retailers such as supermarket chains to increase distribution of products with minimal capital investment. Rationalisation or restructuring of existing branch networks is also part of banks' responses to competitive pressures in the deregulated period. Central to this exercise are staff redundancies, sale and leaseback of branch real estate, branch closures, and in some cases re-engineering of the retail delivery channels aimed at improving cost efficiency and customer service. The self-service technologies have become the indispensable tools in minimising service delivery costs and are particularly promoted in rural areas where branch closures otherwise pose a serious depletion of retail banking services.

The banking system is about to enter another important phase in the deregulation process. The "Six-Pillars" federal government policy that prevented mergers between the four major trading banks and the two largest life companies is currently being challenged. The Commonwealth Bank of Australia and Colonial have agreed on a friendly merger and are awaiting approval of the regulatory bodies. This merger would open the door for other major trading banks to merge with either the remaining major life company, AMP, or with each other, or take over some of the regional banks. It is anticipated that the next two years would see consolidation of the retail-banking sector, which is bound to change the dynamics of productivity in the industry. The historical analysis of productivity undertaken in this study provides additional insight to the changes in productivity of the retail-banking sector and can guide merger decisions by identifying the productivity track record of various banks.

The principal findings for the deregulated period 1986-1995 indicate an overall rise in total productivity driven more by technological progress than technical efficiency. Performance of major

[1] An excellent historical perspective on the Australian financial system can be downloaded from the web site http://www.treasury.gov.au/Publications/FSI/final_report/ (see Chapter 14).

trading banks on technical efficiency is similar to that of regional banks but higher on technological progress. *Literature Review* surveys studies on bank productivity in deregulated periods. *Conceptual Framework* outlines the theory of bank behaviour, measurement of bank efficiency, and MPI. *Methodology* describes the sample and provides an overview of variables. *Empirical Results* highlights the main findings. The paper ends with *Conclusions*, which comments on policy implications, role of technological innovation, and an outlook on future of the sector.

Literature Review

What follows is a review of the literature that investigates bank productivity in a deregulated period using non-parametric techniques. Berg, Forsund, and Jansen (1992) studied the productivity of Norwegian banks before and after deregulation using MPI. The advent of Norwegian banking deregulation was in 1984. They followed the value-added approach to bank behaviour. Analysis revealed total factor productivity (TFP) regress in the pre-deregulation years mainly due to the banks raising their inputs and creating idle capacity in anticipation of increased competition with the introduction of deregulation. The authors report a rapid growth in productivity from 1987 onwards. This rapid growth in TFP was sourced in large gains in TE (about 36 percent) rather than TC. A stable set of frontier banks is identified for 1980-1989 where productivity growth is observed principally among the least efficient banks. By the end of the study period, productivity levels became similar, implying increased competition during the deregulated era.

Elyasiani and Mehdian (1995) investigated the movements in technical efficiency and technological change for two sets of commercial banks grouped on asset size. Data collected for 1979 and 1986 represent the pre- and post-deregulation periods in the U.S.A. Analysis modelled on the intermediation approach to bank behaviour indicates that small and large banks had different efficient frontiers. Small banks emerged as more efficient in the pre-deregulation year, but this gap closed in the post-deregulation year. Small banks exhibited technological progress, whereas large banks showed regress. Market conditions appear to have impacted on the small and large banks differently. Overall, the average efficiency measures declined from 1979 to 1986.

Zaim (1995) studied the effects of liberalisation policies on the economic efficiency of Turkish commercial banks. Using the intermediation approach to modelling bank behaviour, data are collected for the years 1981 and 1990, representing the pre- and post-deregulation periods. Findings indicate that technical efficiency increased on average by 10 percent, while the difference between banks on technical efficiency decreased. On scale efficiency, most banks were able to shift to the most productive scale size (MPSS).[2] In both pre- and post-deregulation periods, most of the inefficiency appears to be sourced in pure technical inefficiency. A rather unexpected finding indicates that state banks were more efficient than privately owned banks. On the other hand, state banks emerged as more prone to allocative inefficiency. Zaim did not report on TC.

Grifell-Tatje and Lovell (1996) investigated the productive efficiency of Spanish savings banks using MPI. The data cover the post-deregulation period 1986-1991, and the authors follow the value-added approach to modelling bank behaviour. Findings show a rapid decline (up to 5.5 percent per year) in measured productivity, mainly due to the worsening performance of best-practice savings banks, i.e., technological regress. At the same time, the standard practice banks tended to catch up with the benchmark banks by declining at a slower pace. The authors also tested two interesting hypotheses, namely, the impact of branching and consolidations on performance. Results indicate that productivity decline in fast-branching banks had been less severe, implying that branching had been an effective competitive strategy during the deregulated period. Mergers

[2] MPSS after Banker (1984) implies that a decision-making unit's production of outputs is maximised per unit of inputs. That is, scale elasticity equals 1.

and acquisitions had a neutral effect on productive efficiency. The authors report no apparent link between size and performance.

Noulas (1997) studied Hellenic banking for the deregulated period 1991-1992. Using Malmquist indices, productivity of state banks is compared against that of the private banks. Bank behaviour is modelled on the intermediation approach. Findings indicate that state banks experienced technological progress (no change for private banks). Regarding TC, state banks appeared to be upgrading their technology in response to new private banks. TE rose for private banks and fell for state banks.

Bhattacharyya, Lovell, and Sahay (1997) investigated the impact of liberalisation on commercial banks in the early years of deregulation of the Indian banking industry. Data examined cover the period 1986-1991, and bank behaviour is modelled on the value-added approach. The authors combined DEA with stochastic frontier analysis. Overall, the results indicate publicly owned banks as the most efficient banks. However, foreign banks appeared to catch up with the public banks by the end of the study period. This is attributed to the more efficient branching of foreign banks in metropolitan areas and their better adaptation to the competitive environment. The authors did not use MPI.

Leightner and Lovell (1998) investigated the performance of Thai banks during a time of liberalisation using MPI. Covering the period 1989-1994, separate specifications were used to produce Malmquist indices that reflect individual bank objectives and central bank objectives. Findings reported indicate that the average Thai bank rapidly advanced in meeting individual organisational objectives. Compared against central bank objectives, the average bank experienced declining TFP. Small foreign banks outperformed others in all categories. On average, productivity grew at 9 percent per year. The authors conclude that deregulation can lead to increased competition, higher profits, and economic growth.

Gilbert and Wilson (1998) studied Korean banks through MPI and followed the user-cost approach to bank behaviour. The deregulated period 1980-1994 reveals large productivity gains for national banks. Regional banks emerge with mixed results. Overall, deregulation enhanced potential output as well as productivity.

Shyu (1998) reported a study of operating efficiency in Taiwan's banking industry for pre- and post-deregulation periods. Data cover the periods 1986-1989 and 1992-1995, and bank behaviour is modelled on the user-cost approach. The findings indicate improvement in overall efficiency and most banks close to being scale efficient. Principal source of inefficiency was identified as allocative rather than technical, in particular during the pre-deregulation period. MPI was not employed in this study. In conclusion, Shyu comments on the importance of increasing size and diversifying output in an effort to raise bank efficiency in the deregulated period.

Wheelock and Wilson (1999) examined U.S. commercial banks categorised in terms of total assets for the deregulated period 1984-1993. Following the user-cost approach to bank behaviour and generating Malmquist indices, they reported large advances in technology accompanied by increases in technical and scale inefficiency. Due to the failure of technological progress to offset the increases in technical and scale inefficiency, productivity decreased during 1984-1993. While few innovator banks were setting new production frontiers, others failed to catch up. Small banks exhibited larger declines in productivity in the first half of the study period, with large banks showing larger declines in the second half. This points to deregulation and technological change affecting banks of different sizes in different ways.

Avkiran (1999a) studied the post-deregulation efficiency of Australian trading banks. Efficiency was decomposed into PTE and SE for the period 1986-1995. TC was not investigated. Bank behaviour was modelled on the intermediation approach. Overall results show declining efficiency scores until 1991 followed by a steady rise. Regional banks emerged as operating at increasing returns to scale, that is, below MPSS, whereas the major trading banks tended to operate at decreasing returns to scale, i.e., above MPSS. Therefore, given the sample characteristics, the changes in PTE (rather than TE) are reported in *Empirical Results* of this paper.

Literature review shows that there is no clear link between productivity and deregulation. Results appear to vary depending on the country, bank ownership, and size. However, those authors who report a rise in productivity during deregulation attribute this to enhanced competition and output diversity.

Conceptual Framework

Modelling Bank Behaviour

Measuring productivity requires determination of inputs and outputs. This can be difficult because there is no consensus amongst researchers about the inputs and outputs of a bank. Nevertheless, there are two principal schools of thought on bank behaviour that can help selection of inputs and outputs. One of these is the *intermediation* approach to modelling bank behaviour where deposits are regarded as being converted into loans (Mester 1987). The intermediation approach is preferable since it normally includes interest expense, a large proportion of any bank's total costs (Elyasiani and Mehdian 1990; Berger and Humphrey 1991). The alternative is the production approach where banks are regarded as using labour and capital to generate deposits and loans; these outputs are usually measured in number of accounts rather than dollars.

A third approach to modelling bank behaviour is that of value-added (Berger and Humphrey 1992). Under this approach high value creating activities such as making loans and taking deposits are classified as outputs and measured in dollar terms, whereas labour, physical capital, and purchased funds are classified as inputs (Wheelock and Wilson 1995).

A fourth approach is known as user-cost. The user-cost approach assigns an asset (e.g., personal loans) as an output if the financial returns are greater than the opportunity cost of funds. Similarly, a liability item (e.g. savings accounts) is regarded as an output if the financial costs are less than the opportunity cost. If neither of these conditions is satisfied, the asset or the liability is classified as input (Berger and Humphrey 1992). The user-cost approach is usually attributed to Hancock (1986). According to Hancock, user costs can be calculated for all assets and liabilities on the balance sheet. Assignment of assets and liability items as inputs or outputs may change with movements in interest rates and service charges.

Measuring Bank Efficiency

In the last decade of the 20th century, the focus of bank efficiency measurement has shifted to x-efficiencies, that is, the ability of management to control costs and generate revenues (Elyasiani and Mehdian 1990; Ferrier and Lovell 1990; English et al. 1993; Allen and Rai 1996; Mester 1996). X-efficiency comprises allocative and technical efficiencies of banks. Allocative inefficiency is defined as a decline in performance from selecting an ineffective production plan, whereas technical inefficiency is defined as the poor implementation of this production plan (Berger, Hancock, and Humphrey 1993). Existing studies indicate that x-inefficiencies constitute 20 percent or more of costs, whereas economies of scale and scope inefficiencies account for less than 5 percent of costs in banking (Berger, Hunter, and Timme 1993).

There is no consensus on the best procedure for measuring x-efficiencies. The principal measurement problem is distinguishing variations in x-efficiency from random error. Examples of different procedures are the econometric frontier approach, the thick frontier approach, the distribution-free approach, and DEA. Each of these approaches makes different assumptions about the distribution of x-efficiency differences and random error (Berger, Hunter, and Timme 1993). DEA, the technique adopted in this study for generating MPI, usually assumes no random error, thus implying that all deviations from the estimated efficient frontier actually constitute x-inefficiencies. Other researchers who have recently used DEA in measuring relative bank efficiency include Berg, Forsund, and Jansen (1992); Berg et al. (1993); Drake and Howcroft (1994); Elyasiani and Mehdian (1995); Favero and Papi (1995); Fukuyama (1995); Haag and Jaska (1995); Sherman and Ladino (1995); Wheelock and Wilson (1995); Zaim (1995); Grifell-Tatje and Lovell (1996); Miller and Noulas (1996); Bhattacharyya, Lovell, and Sahay (1997); and Resti (1997). A more comprehensive survey of efficiency analysis of financial institutions can be found in Berger and Humphrey (1997).

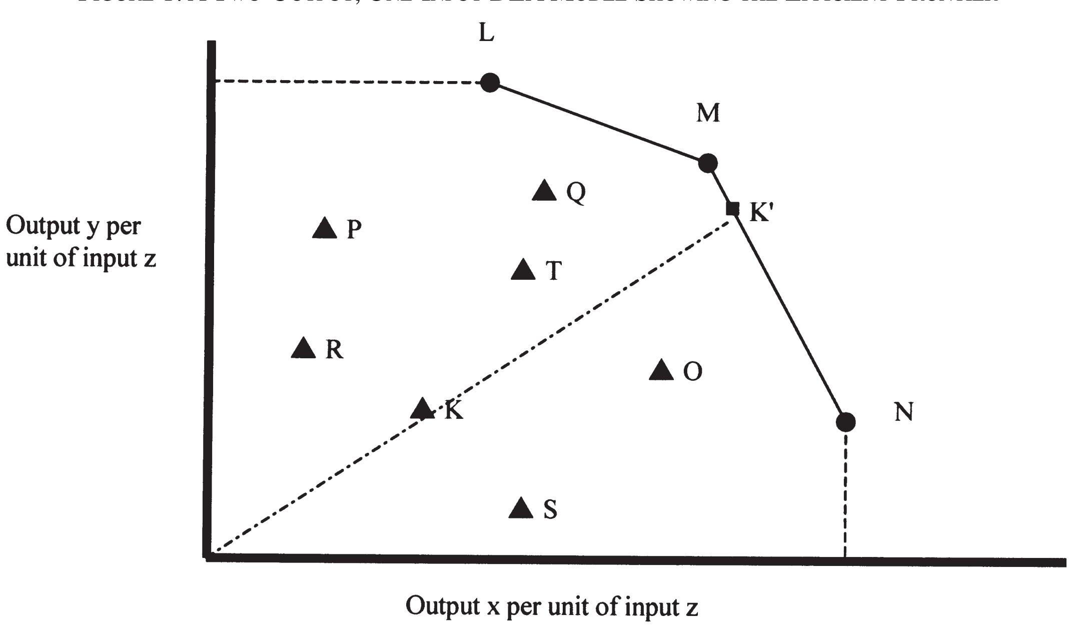
DEA is a non-parametric linear programming technique that computes a comparative ratio of outputs to inputs for each unit, which is reported as the relative efficiency score. The efficiency score is usually expressed as either a number between 0 and 1 or a percentage between 0 and 100. A decision-making unit (DMU) with a score less than 1 is deemed inefficient relative to other units. DEA's main usefulness, however, lies in its ability to generate potential improvements (i.e., achievable targets) for inefficient units and identifying the branches to benchmark.

Traditional DEA measures the technical efficiency of DMUs as opposed to their allocative efficiency. In the context of DEA, allocative efficiency is defined as the effective choice of inputs vis à vis prices with the objective of minimising production costs (i.e., selection of an effective production plan), whereas technical efficiency investigates how well the production process converts inputs into outputs (i.e., effective implementation of the production plan).

An advantage of DEA is that there is no preconceived structure imposed on the data in determining the efficient units (Banker 1984; Al-Faraj, Alidi, and Bu-Bsharit 1993; Burley 1995; Mester 1996). That is, DEA does not assume a particular production technology or correspondence. The importance of this feature of DEA is that a bank's efficiency can be assessed based on other observed performance. As an efficient frontier technique, DEA identifies the inefficiency in a particular DMU by comparing it to similar DMUs regarded as efficient, rather than trying to associate a DMU's performance with statistical averages that may not be applicable to that DMU.

Figure 1 shows a simple DEA model to highlight this principle. The solid line going through efficient DMUs *L*, *M*, and *N* depicts the *efficient frontier* that represents achieved efficiency.

FIGURE 1. A TWO-OUTPUT, ONE-INPUT DEA MODEL SHOWING THE EFFICIENT FRONTIER



Clearly, the efficient frontier envelops all other data points, thus giving rise to the name *data envelopment analysis*. For example, DMU *K* is classified as inefficient in this sample of ten units, and it needs to travel to *K* on the frontier before it can also be deemed efficient. DMU *K* would be directly compared to units *M* and *N* on the efficient frontier (i.e., its reference set or peer group) in calculating its efficiency score. In this case, DMU *M* would make a greater contribution to DMU *K*'s score.

Malmquist Productivity Index

The Malmquist index used in this study to measure bank productivity change is based on the seminal study by Caves, Christensen, and Diewert (1982). This approach can be illustrated by a simple example. Assume the banking sector produced 300,000 mortgages (output) in period *t* employing 5,000 loan officers (input). In period *t+1* the sector produced 450,000 mortgages with 5,500 officers. It is also noted that using period *t* technology the sector would have produced only 400,000 mortgages with period *t+1* input. The output-orientated Malmquist index takes the ratio of period *t+1* output to the output based on period *t* technology with period *t+1* input, i.e., 1.125 (450,000/400,000). Essentially output orientation compares outputs of period *t+1* with what would have been produced under period *t* technology using period *t+1* inputs. The index of 1.125 implies a rise in productivity.

The Malmquist productivity index is defined with distance functions. When panel data are used, distance functions permit the researcher to describe multiple input/multiple output production technologies without behavioural objectives such as profit maximisation or cost minimisation (Coelli, Rao, and Battese 1998). In an output distance function, the aim is to maximise the proportional expansion of the output vector for a given input vector. Equation 1 shows the Malmquist total factor productivity index decomposed into technical efficiency and technological change after Fare et al. (1994). The ratio outside the square brackets represents the change in technical efficiency, and the expression in square brackets depicts technological change. To assist the interpretation of equation 1, it is noted that $d^t(y_{t+1}, x_{t+1})$ represents the distance between the period *t+1* observation and the period *t* technology.

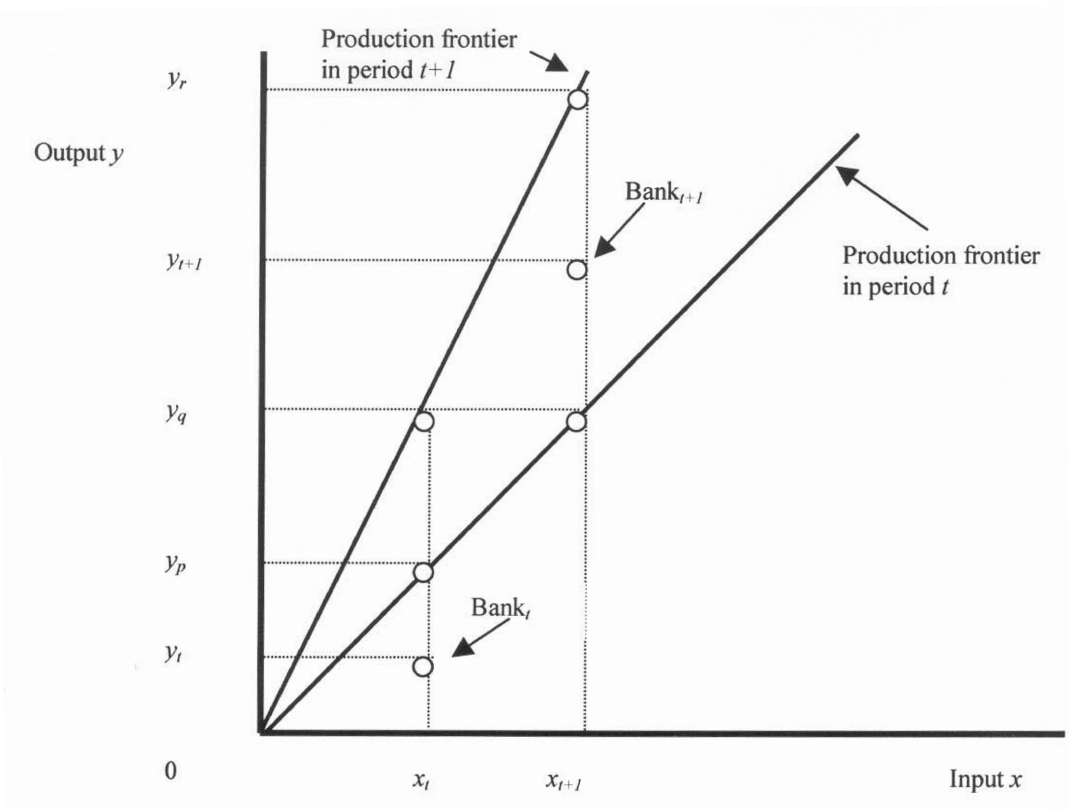
$$M(y_t, x_t, y_{t+1}, x_{t+1}) = \frac{d^{t+1}(y_{t+1}, x_{t+1})}{d^t(y_t, x_t)} \left[\frac{d^t(y_{t+1}, x_{t+1})}{d^{t+1}(y_{t+1}, x_{t+1})} \text{ x } \frac{d^t(y_t, x_t)}{d^{t+1}(y_t, x_t)} \right]^{1/2} \tag{1}$$

Figure 2 illustrates the measures inherent in equation 1 using the example of a single output *y* and a single input *x*. The bank is producing at productivity less than what is feasible under each period's technology. MPI under constant returns to scale technology indicates a rise in potential productivity as the technology frontier shifts from period *t* to *t+1*. For example, the bank at time *t* could produce output y_p for input x_t; for the same input it could produce output y_q at time *t+1*. Change in technical efficiency and technological change depicted in Figure 2 are represented by the distance functions in equations 2 and 3 respectively.

$$\textit{Technical Efficiency Change} = \frac{y_{t+1}/y_r}{y_t/y_p} \tag{2}$$

$$\textit{Technological Change} = \left[\frac{y_{t+1}/y_q}{y_{t+1}/y_r} \text{ x } \frac{y_t/y_p}{y_t/y_q} \right]^{1/2} \tag{3}$$

FIGURE 2. MALMQUIST PRODUCTIVITY INDEX USING CONSTANT RETURNS TO SCALE TECHNOLOGY



Distance functions in the MPI are calculated using DEA like linear programs. Benefits of using a DEA like efficient frontier technique include (a) non-reliance on price information, (b) the fact that organisations need not be assumed efficient, and (c) the fact that total factor productivity can be decomposed into changes in technical efficiency and technological change. Total factor productivity is equal to the product of technical efficiency and technological change. In turn, technical efficiency is equal to the product of PTE and SE. However, even though the product of TE and TC equals TFP, the two components may be changing in opposite directions.

Output orientated DEA like linear programs are summarised in equations 4-7. Equations 4 and 5 represent the case where a datum point observed in a period is compared to production technology (frontier) of that period. Similarly, in equations 6 and 7, data points are compared to technology of the previous period. It should be noted that the equations 4-7 have to be solved once for each bank in each pair of adjacent time periods. To construct a chained index, it is necessary to solve for $Nx(3T\text{-}2)$ linear programs, where N is the number of banks and T is the number of time periods (Coelli, Rao, and Battese 1998). That is, for ten banks across ten years, it is necessary to solve 280 linear programs, i.e., [10x(3x10-2)].

$$\begin{aligned} \left\{d^{t+1}\left(y_{t+1}, x_{t+1}\right)\right\}^{-1} &= \max_{\phi,\lambda} \Phi \\ \text{st} \quad -\Phi y_{i,t+1} + Y_{t+1}\lambda &\geq 0 \\ x_{i,t+1} - X_{t+1}\lambda &\geq 0 \\ \lambda &\geq 0 \end{aligned} \tag{4}$$

where Φ = technical efficiency
st = subject to
Y = output matrix
λ = N x 1 vector of constants
X = input matrix

$$\begin{aligned} \left\{d^t\left(y_t, x_t\right)\right\}^{-1} &= \max_{\phi,\lambda} \Phi \\ \text{st} \quad -\Phi y_{i,t} + Y_t\lambda &\geq 0 \\ x_{i,t} - X_t\lambda &\geq 0 \\ \lambda &\geq 0 \end{aligned} \tag{5}$$

$$\begin{aligned} \left\{d^{t+1}\left(y_t, x_t\right)\right\}^{-1} &= \max_{\phi,\lambda} \Phi \\ \text{st} \quad -\Phi y_{i,t} + Y_{t+1}\lambda &\geq 0 \\ x_{i,t} - X_{t+1}\lambda &\geq 0 \\ \lambda &\geq 0 \end{aligned} \tag{6}$$

$$\begin{aligned} \left\{d^t\left(y_{t+1}, x_{t+1}\right)\right\}^{-1} &= \max_{\phi,\lambda} \Phi \\ \text{st} \quad -\Phi y_{i,t+1} + Y_t\lambda &\geq 0 \\ x_{i,t+1} - X_t\lambda &\geq 0 \\ \lambda &\geq 0 \end{aligned} \tag{7}$$

Methodology

Ten Australian trading banks in the deregulated period constitute the study sample. Four of the banks are major trading banks and six are regional banks as shown in Table 1; others could not be included due to inconsistent availability of data between 1986 and 1995, primarily due to mergers, acquisitions, or establishment of new banks. Foreign banks were omitted because between 1986 and 1995 most operated as subsidiary banks with restrictive capital adequacy requirements and dealt mainly in wholesale banking. The research is designed to follow the technical efficiency and technological progress of the retail-banking sector across 1986-1995.

It was possible to collect data on four inputs (staff numbers, deposits, interest expense, and non-interest expense) and three outputs (net loans, net interest income, and non-interest income) of interest to this research project through the Reserve Bank of Australia. In the spirit of directly measuring management's success in controlling costs and generating revenues in a discriminating model, net loans, deposits, and staff numbers were dropped from the analysis, leaving two input and two output variables. Modelling output orientation, the analysis was run with *interest expense* and *non-interest expense* as inputs, and *net interest income* and *non-interest income* as outputs.[3] Table 2 reports the descriptive statistics for the four variables.

[3] Non-interest expense equals before-tax total expenses less interest expenses and charges for bad and doubtful debts. Net interest income equals interest income less interest expense. Non-interest income equals all revenues less interest income and bad debt recoveries.

TABLE 1. TRADING BANKS IN THE STUDY SAMPLE

Name of Trading Bank	Abbreviation Used
Advance Bank Australia	Advance
ANZ Banking Group (major)	ANZ
Bank of Queensland	BankQLD
Bank of South Australia	BankSA
Bank of Western Australia	BankWA
Commonwealth Bank of Australia (major)	CBA
Macquarie Bank	Macquarie
National Australia Bank (major)	NAB
State Bank of NSW	SBankNSW
Westpac Banking Corporation (major)	Westpac

TABLE 2. DESCRIPTIVE STATISTICS FOR INPUTS AND OUTPUTS

Pearson Correlations	Interest Expense		Non-interest Expense		Net Interest Income		Non-interest Income	
Interest Expense	1.000							
Non-interest Expense	0.906		1.000					
Net Interest Income	0.891		0.975		1.000			
Non-interest Income	0.890		0.971		0.932		1.000	
Year	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
1986	1746.269	1887.275	692.227	795.538	633.745	741.377	343.287	410.234
1987	1913.887	1921.185	760.818	811.826	695.572	758.512	378.730	418.565
1988	1474.491	1762.033	570.630	735.517	556.155	741.139	259.386	325.452
1989	1957.122	1904.986	769.754	806.322	717.097	766.860	425.457	507.899
1990	1906.573	1954.506	753.768	821.163	700.580	781.700	421.179	511.632
1991	1930.631	1934.455	762.320	813.731	711.739	772.200	422.511	510.558
1992	1650.783	1953.182	620.676	806.209	560.654	746.463	379.176	525.028
1993	1984.029	1912.077	766.789	811.630	710.504	754.873	425.592	513.635
1994	1604.335	1911.475	645.793	828.506	586.701	771.519	364.071	517.832
1995	1904.688	1981.943	756.982	829.497	707.721	783.840	424.414	518.527
1986-95	1697.751	1690.915	818.138	698.842	789.104	641.418	459.924	492.291

Note:SD stands for "standard deviation."

The selected variables can be argued to fall under the intermediation approach to modelling bank behaviour where interest expense is a proxy for deposits and net interest income is a proxy for loans. Non-interest expense represents the resources expended in converting deposits to loans, and non-interest income represents the fees charged for services. Examples of other studies where these variables have been used include Charnes et al. (1990); Yue (1992); Miller and Noulas (1996); Bhattacharyya, Lovell, and Sahay (1997); Brockett et al. (1997); Leightner and Lovell (1998); and Avkiran (1999b). The dollar entries were deflated back to the base year 1986.

The main limitation of this study is the assumption of a common technology by projecting the small regional banks and the major trading banks against the same production frontier. Due to the small sample size, it was not feasible to repeat the analysis separately for the two groups. Hence, it is unknown whether the productivity differences between the major banks and regional banks are due to the characteristics of the markets in which they operate.

Empirical Results

Table 3 summarises the changes in TFP for the study period on an individual bank basis and across each year. On average the retail-banking sector increased its TFP by 3.2 percent per year between 1986 and 1995. This compares favourably to the cost efficiency (operating expenses/total assets) of major trading banks that varied between 3.2 percent and 3.8 percent for the same period (Financial System Inquiry 1997); comparable international banks showed cost efficiencies between 2.6 percent and 4.3 percent. This indicates that Australia (or at least the major banks that hold the majority of bank assets) performed well in the context of international benchmarks.

NAB makes the largest contribution to the rise in TFP, whereas SBankNSW appears to reduce TFP. In terms of annual sector performance, 1993 is associated with the largest rise in TFP due to

TABLE 3. CHANGES IN TOTAL FACTOR PRODUCTIVITY (TFP)

Bank	1987	1988	1989	1990	1991	1992	1993	1994	1995	Mean(SD) Bank TFP*
Advance	0.953	1.021	0.920	1.003	1.143	1.050	1.089	1.047	1.003	1.023 (.067)
ANZ	1.187	0.969	0.940	0.934	1.083	1.016	1.051	1.124	0.947	1.024 (.090)
BankQLD	1.034	1.217	0.869	0.943	1.116	1.140	1.065	0.988	0.893	1.024 (.117)
BankSA	1.012	1.018	1.128	1.053	0.351	1.461	1.718	0.800	1.393	1.021 (.398)
BankWA	0.997	1.183	1.031	0.754	0.936	1.166	1.064	1.051	1.094	1.023 (.129)
CBA	0.940	1.174	1.022	0.914	1.148	0.871	1.069	1.080	1.012	1.021 (.104)
Macquarie	1.230	0.942	1.080	0.908	1.054	0.905	1.071	1.161	0.839	1.014 (.130)
NAB	1.057	1.122	1.032	0.941	1.044	1.037	1.139	1.126	0.866	1.037 (.090)
SbankNSW	0.962	1.032	1.040	0.912	1.085	0.920	0.988	0.975	1.048	0.994 (.060)
Westpac	0.996	1.129	0.975	1.071	0.976	0.861	1.246	0.995	0.955	1.017 (.112)
Mean (SD) Annual TFP	1.037 (.098)	1.081 (.096)	1.004 (.078)	0.943 (.089)	0.994 (.236)	1.043 (.182)	1.150 (.211)	1.035 (.104)	1.005 (.158)	1.032**

Notes: SD provided in parentheses; * Geometric mean across the period; ** Average of mean annual TFP.

TABLE 4. CHANGES IN PURE TECHNICAL EFFICIENCY (PTE)

Bank	1987	1988	1989	1990	1991	1992	1993	1994	1995	Mean(SD) Bank TFP*
Advance	0.957	0.991	0.902	1.009	1.015	1.144	1.016	1.000	1.000	1.002 (.064)
ANZ	1.000	1.000	1.000	1.000	0.897	1.115	1.000	0.983	0.997	0.998 (.055)
BankQLD	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000 (.000)
BankSA	1.022	0.915	1.053	1.048	0.340	1.796	1.399	0.760	1.409	0.994 (.419)
BankWA	0.908	1.150	1.020	0.761	0.832	1.302	1.038	1.020	1.098	1.002 (.165)
CBA	1.000	0.994	1.006	0.971	1.030	0.934	0.949	0.969	1.165	1.000 (.068)
Macquarie	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000 (.000)
NAB	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000 (.000)
SbankNSW	0.889	1.034	1.007	0.925	1.014	1.001	0.965	0.951	1.041	0.980 (.052)
Westpac	1.000	1.000	1.000	1.000	1.000	0.973	1.028	0.846	1.063	0.988 (.059)
Mean (SD) Annual PTE	0.978 (.045)	1.008 (.058)	0.999 (.038)	0.971 (.080)	0.913 (.211)	1.127 (.259)	1.040 (.129)	0.953 (.084)	1.077 (.129)	1.007**

Notes: SD provided in parentheses; * Geometric mean across the period; ** Average of mean annual PTE.

both PTE and TC improving in the same year. Years 1990 and 1991 are associated with a reduction in TFP (see bottom row of mean values in Table 3). Coefficient of variation (i.e., standard deviation/mean) of TFP reveals highest sector relative variability in 1991 and highest bank variability with BankSA (not reported in tables).

Table 4 summarises the changes in PTE. On average the sector increased its PTE by 0.7 percent per year. Advance and BankWA show a small rise in PTE, with the remaining banks either experiencing an overall reduction in PTE or showing no change between 1986 and 1995. Years 1992, 1993, and 1995 are the only years showing a substantial sectoral growth in PTE, with other years (except 1988) showing an overall reduction in PTE (greatest reduction is in 1991). Relative variability of PTE is highest in 1992 and with BankSA. An explanation of the variability in BankSA's performance is provided by the technical inefficiency in interest expense usage almost doubling from 1990 to 1991. This, in turn, is attributed to the particularly large non-accruals in 1991 that lead to state government indemnifying $2.2 billion of BankSA's capital (KPMG 1992).

Declines in PTE should be interpreted with caution. For example, in BankSA, the technological progress of 16.7 percent in 1991 (see Table 5) would have further amplified the observed decline in PTE. This is because PTE is now measured against an efficient frontier that represents better productive possibilities under technological advance. In principle, if the movement toward

TABLE 5. TECHNOLOGICAL CHANGE (TC)

Bank	1987	1988	1989	1990	1991	1992	1993	1994	1995	Mean(SD) Bank TFP*
Advance	1.025	1.050	0.997	1.001	1.090	0.962	1.022	1.047	1.003	1.021 (.037)
ANZ	1.142	1.032	0.992	0.982	1.194	0.915	1.090	1.056	0.922	1.032 (.095)
BankQLD	1.034	1.217	0.869	0.943	1.116	1.140	1.065	1.000	0.883	1.024 (.118)
BankSA	1.004	1.110	1.058	1.014	1.167	0.905	0.986	1.039	1.011	1.030 (.075)
BankWA	1.080	1.019	1.025	0.996	1.088	0.901	1.027	1.030	1.008	1.018 (.054)
CBA	0.943	1.196	1.001	0.942	1.113	0.962	1.126	1.089	0.863	1.021 (.109)
Macquarie	1.230	0.942	1.080	0.908	1.054	0.905	1.071	1.161	0.839	1.014 (.130)
NAB	1.057	1.122	1.032	0.941	1.044	1.037	1.139	1.126	0.866	1.037 (.090)
SbankNSW	1.082	1.011	1.015	0.989	1.063	0.919	1.027	1.033	1.007	1.015 (.046)
Westpac	1.023	1.129	1.020	0.997	1.151	0.955	1.043	1.074	0.898	1.029 (.080)
Mean (SD) Annual TC	1.062 (.079)	1.083 (.087)	1.009 (.056)	0.971 (.035)	1.108 (.050)	0.960 (.076)	1.060 (.048)	1.066 (.048)	0.930 (.070)	1.028**

Notes: SD provided in parentheses; * Geometric mean across the period; ** Average of mean annual TC.

the frontier (i.e., gains in PTE) were less than the shift of the frontier (i.e., technological progress), then there would be an overall decline in measure of PTE.

Table 5 highlights the numbers for TC. On average the sector shows an improvement of 2.8 percent per year. Regarding TC (see Table 5), all the banks exhibit overall progress of similar magnitudes across the period where NAB can claim the greatest progress and Macquarie the smallest progress. As a sector, the greatest progress takes place in 1991, with years 1990, 1992, and 1995 showing technological regress.

Figure 3 charts the changes in TFP, PTE, and TC for the deregulated period 1986-1995 where values above 1 indicate a gain in productivity. Figure 3 shows that up to 1990 the changes in PTE and TC were in the same direction. After 1990, PTE and TC changed in opposite directions, switching positions from one year to the next. The overall outcome of this interaction was a fluctuating TFP for the retail-banking sector. The only sustained growth in TFP in this ten-year deregulated period is between 1990 and 1993.

Table 6 illustrates the mean productivity change grouped for major trading banks and regional banks. The performances of the two groups are similar on PTE although there is a higher variability amongst the regional banks. Regarding TC, major banks exhibit a higher technological progress compared to the regional banks. The net effect of these changes is a smaller improvement in TFP

FIGURE 3. SUMMARY OF PRODUCTIVITY CHANGES IN RETAIL BANKING SECTOR, 1986-1995

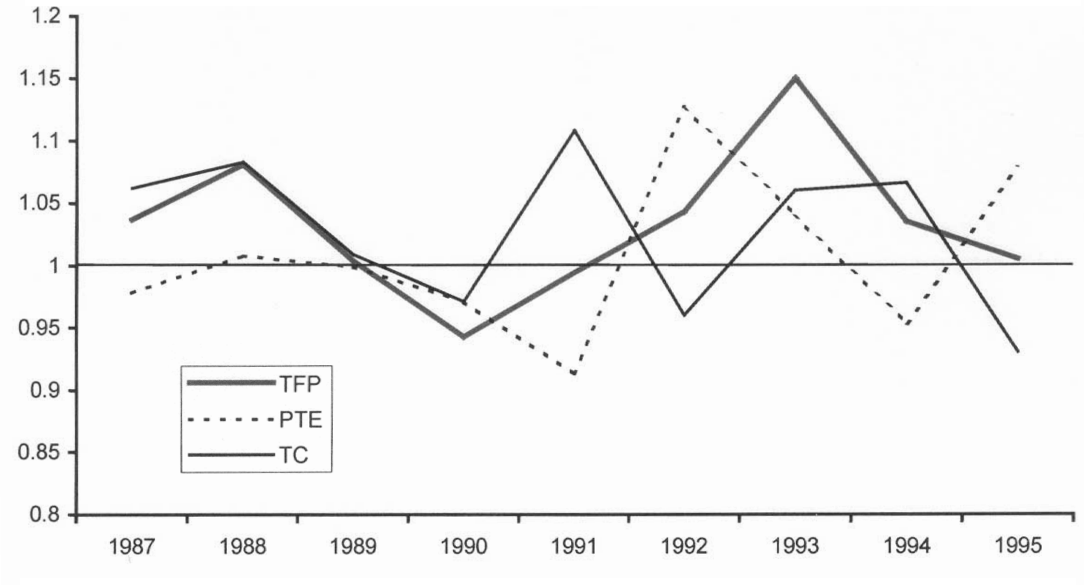


TABLE 6. SUMMARY OF MEAN CHANGE (AND STANDARD DEVIATION) IN PRODUCTIVITY GROUPED FOR MAJOR TRADING BANKS AND REGIONAL BANKS, 1986-1995

	Major Banks	Regional Banks
ΔTFP	1.025 (0.008)	1.016 (0.011)
ΔPTE	0.997 (0.006)	0.996 (0.009)
ΔTC	1.030 (0.007)	1.020 (0.006)

Notes: Δ denotes change.

(with larger variability) amongst the regional banks. Figure 3 also indicates that, overall, TFP is driven more by TC than PTE.

Conclusions

Key Findings and Policy Implications

The initial decline in TFP from 1988 to 1990 followed by a steady rise from 1991 to 1993 can be explained by the events of the period. The unprofitable lending decisions in the late 1980s following deregulation would have impacted the interest income (output) of most banks. On the input side of the equation, interest expense emerges as a significant source of inefficiency as banks were allowed to compete with each other on deposit rates and types of interest paying products. This was particularly noticeable because banks had been slow in setting up a trade-off between offering competitive deposit rates and raising fees. Once the banks recovered from the consequences of their poor decisions and the market rules of competitive engagement became clearer, the TFP shows a steady rise in the early1990s.

Findings in the Australian retail-banking sector for the deregulated period 1986-1995 indicate an overall rise in total productivity (on average, 3.2 percent per year) driven more by technological progress than technical efficiency. Whereas all the trading banks exhibit an overall technological progress across 1986-1995, the less than 1 average changes in PTE for the same period imply that about half the banks were unable to keep up with the technological change. Can this be construed as an indication of degree of control managers exercise over the processes of PTE versus TC? For example, an effective way to raise PTE is to reduce non-interest expenses, e.g., salaries. However, forced redundancies often lead to interruption of services, usually followed by public and political backlash. Thus, it can be argued that management has limited control in this area. On the other hand, management can proceed with installation of a new banking technology with relative ease, suggesting that it has more control over technological progress.

Results indicate a small overall rise in PTE (on average 0.7 percent per year) and a more significant overall rise in TC (on average 2.8 percent per year). Theoretically, overall improvement in PTE implies diffusion of technology. PTE improvement at bank level is evidence of that organisation catching up to the production frontier that represents the period's technology. On the other hand, improvement in TC is considered progress of this technology and constitutes evidence of innovation. Distinguishing between improvement in PTE and TC is significant for policy formulation in retail banking. For example, low growth rates in productivity could be a consequence of institutional barriers hindering the diffusion of innovations. Such a case suggests that efforts exerted in removing institutional barriers should be more effective than developing more innovations (Grosskopf 1993).

Similarly, if the government and regulatory bodies were aware of the TFP improvement being mainly due to technological progress, then it is possible to argue for support of capital investment in technology in the form of preferential tax treatment. Such a policy could provide the additional incentive for management to take a more people-oriented approach to PTE. That is, instead of planning for mass redundancies in order to address the expense side of the productivity equation, which is a proposition particularly attractive to bank management in the small Australian market, staff replaced by technological innovation can be re-trained in selling and customer service.

Role of Technological Innovation

Technological innovation played a principal role in shaping financial service delivery during the period under study. The alternative ways of customer access and product distribution enabled by technological innovation have lowered the barriers to entry and reduced bank margins (Financial System Inquiry 1997). The empirical findings in this study regarding the dominance of technological progress over gains in technical efficiency add further support to this contention.

Technological innovation can be construed as a sign of dynamic efficiency in the Australian retail banking sector where banks take advantage of new cost-effective technologies and pursue product and market development. Development of derivative products, telephone banking, electronic transaction at point of sale (EFTPOS), and networked automatic teller machines (ATM) are some of the main examples for the period. Post-1995 has witnessed organisational innovation to capture market share. For example, CBA has recently collaborated with Woolworths to offer basic banking facilities in supermarkets.

Performance of major trading banks on technical efficiency is similar to that of regional banks but higher on technological progress. This observation implies that technological progress in banks has historically been an expensive exercise and that major banks with a larger capital base have been better positioned to undertake such investments. It also implies that economy of scale is one of the criteria in decisions about technology investment in banks. The global nature of the business of major trading banks compared to the local nature of regional banks could be an added imperative for these banks to pursue technological progress. The larger picture suggests that the major banks may be the innovators with regional banks following closely.

A further comment can be made on the slower technological progress observed in regional banks by referring to a previous study where the findings indicate that regional banks almost invariably operated at increasing returns to scale between 1986 and 1995 (Avkiran 1999a). It can be argued that regional banks can benefit from expanding their operations through capital investment in technology or renting technology.

Future of the Banking Sector

Future of the Australian retail-banking sector includes a reduction of the gap between the major banks and regional banks in technological progress. That is, as the implementation of technological innovations becomes less expensive and easier, the regional banks will catch up with the major banks in technological progress. The increasing willingness of major banks that invest in technological innovations to rent out services to other institutions (with the intention of enjoying greater economies of scale) will also bring about a convergence between the two groups of banks, e.g., mortgage origination and call centres.

As the security of electronic transactions increases, other technological innovations will continue to drive productivity. For example, self-service technologies (SST) provide a potential for future productivity gains. However, some SST such as telephone banking and Internet banking have not enjoyed the same degree of acceptance seen with ATM and EFTPOS. A key factor impeding the full acceptance of SST is the customer's preference for human contact. Thus, there is an overriding need to keep SST customer-focussed as they are further developed in the quest for competitive advantage. In pursuit of productivity levels comparable to global benchmarks, banks will have to reconcile such seemingly opposite forces.

A third factor that could change the productivity of the sector is merger activity. Although there is no conclusive evidence on efficiency gains resulting from bank mergers in Australia (Avkiran 1999b), the productivity of the sector can be affected. For example, the proposed merger between CBA and Colonial has currently placed mergers back on the political agenda. Such mergers are expected to reduce the number of players in the sector and possibly open the Australian banks to takeovers from overseas. The analysis of TFP, PTE, and TC in this study provides valuable information to regulatory and bank decision-makers contemplating various takeover scenarios that are invariably promoted on grounds of productivity gains.

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